Journal of Mathematics and Data Science

[ISSN 3005-544X]
Volume: 04 Issue: 01 | March-2026

JMDS

ANALYSIS AND VISUALISATION OF MENTAL HEALTH DATA IN SOUTH SUDAN: EXPLORATORY DATA ANALYSIS

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Cite this article in APA

Malang, A. B., Kamanu, T. K. K., Ndetei, D. M., Luketero, S. W., & Mohammed, Z. M. S. (2026). Analysis and visualisation of mental health data in South Sudan: Exploratory data analysis. *Journal of mathematics and data science, 4*(1), 23-40. https://doi.org/10.51317/jmds.v4i1.950

OPEN ACCESS
A publication of Editon Consortium Publishing (online)

Article history
Received: 2026-01-12
Accepted: 2026-02-21
Published: 2026-03-26

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Abstract

This study presents an exploratory data analysis and visualisation of mental health data in South Sudan, a total of 72,414 reported cases collected between 2020 and 2022 from the National Ministry of Health via the DHIS 2. The Demographic Health Information System 2 (DHIS 2) is a data collection tool that collects data from the health facilities across the country. The mental health statistical analysis covers data for acute stress, depression, psychosis, grief, post-traumatic stress disorder, substance and drug abuse, suicide attempts, other mental health conditions and other significant mental health complaints. The study identifies trends in mental health data needed by the health providers. The detailed data analysis will facilitate data-driven interventions, planning, and monitoring of the mental health programme. The diagnosis of mental health cases was classified using the Diagnostic and Statistical Manual of Mental Disorders (DSM). The exploratory data analysis (EDA) conducted using R statistical software (R Markdown) provides good visualisations and tabulations of the mental health data. Substance & drugs abuse, post-traumatic stress disorders, suicide attempts, grief, depression and acute stress are the common mental problems in South Sudan. The data show that the acute mental health cases are increasing at a rate of 41 per cent annually. The findings are useful for re-programming mental health interventions and increasing public awareness about mental health.

Keywords: Data visualisation, exploratory data analysis, South Sudan, types of mental disorders.

1.0 INTRODUCTION

Mental disorders are classified under non – communicable diseases and represent a significant public health burden. The major types of mental health disorders examined in this study are acute stress, depression, psychosis, grief, post-traumatic stress disorder, substance and drug abuse, suicide attempts, other mental health conditions and other significant mental health complaints. The exploratory data analysis provides statistical information about each type of mental disorder, including death cases.

Mental Health Data Visualisation increases Public Awareness and planning for mental health programmes. This study provides grounds to present trends and visualisation of mental health data, which is crucial for decision-making.

Stress is a phenomenon where an individual fails to function at their normal capacity due to a threatening or challenging problem at the workplace, home or in the neighbourhood. Stress is a common thing that any living thing can experience frequently in their lifetime; it can be short-term stress or long-term stress.

A drug is any chemical substance that can affect the functioning of a living being (David M. Ndetei, 2014). According to the World Health Organisation, alcohol is a psychoactive substance with dependence – producing properties that has been widely used in many cultures for centuries, which is produced by fermenting sugar and yeast. The four types of alcohol are ethyl (ethanol), isopropyl, denatured and rubbing. Only ethanol alcohol can be consumed; the rest is poisonous and only useful for other non-consumption uses.

Some of the drugs have positive effects, especially those that have been scientifically tested and approved by the WHO for uses such as medical drugs, but many other unapproved drugs have negative effects on mental health, such as alcohol, heroin, narcotics, opium, cocaine, coffee, tobacco, khat (miraa) and many other drugs. In this study, we will refer to drugs as substances that harm our body and mental well-being. The psychoactive drugs are categorised into three categories, namely:

Stimulants: The stimulants stimulate how the brain works and make you feel high, awake or more energetic, e.g., Cocaine, Tobacco, Mirra or Caffeine, etc. Depressants: These de-stimulate how the brain works by slowing down how the brain works, making our body feel relaxed, e.g., alcohol, heroin, morphine, fentanyl, opium, etc. Hallucinogens: The induced change in how an individual thinks or perceives things at his/her environment.

These drugs play a role in affecting how the brain works, and we become addicted to them, causing high dependence on them, both psychologically and physically. Alcohol is classified as one of the leading addictive drugs. The abuse of alcohol causes most road accidents, suicide, physical assaults, drowning and other forms of violence. It is estimated that (20%) of the nonroad transportation injuries are cause by alcohol, (38%) of drowning cases are cause by alcohol, (50%) of falls are cause by alcohol, (28%) of the suicides are cause by alcohol, (46%) of the assaults are cause by alcohol, (16%) of the child abuse are cause by alcohol and globally (1.5%) of the deaths are causes by alcohol (David M. Ndetei, 2014). Considering alcohol (volume of 100mL of drink, 1 unit = 1 mL of spirit) for men and women of the same weight, the safe drinking limit for a woman is 14 units per week, while for men it is 21 units per week. Grief is trouble, annoyance or an overwhelming emotional feeling when something or someone is lost.

Depression makes a person unproductive. There are three types of depression disorder, namely major depression, dysthymia and bipolar. Five to 6 per cent of the population will have a depressive disorder during their lives (David M. Ndetei, 2014). External factors, e.g., socioeconomic problems (grief, financial loss, job loss, retirement, etc.), genetics (inheritance from depressed parents), and illness (Cushing's disease, thyroid, cancer, etc.) are the major causes of depression. Depressed people are usually hostile or fond of substance and drug abuse. The use of data – driven technologies helps in the diagnostic and treatment of anxiety (Panagiotakopoulos et al., 2010) and (Piyanjali et al., 2009).

Post-Traumatic Stress Disorder (PTSD) is a mental health disorder that occurs when a person is exposed to or has experienced traumatic events such as wars, conflicts/violence, rape, witnessing killing, accidents and natural disasters such as flooding, landslides, volcanoes, and earthquakes. The criteria for a person exposed to traumatic events (David M. Ndetei, 2014).

Every adult in South Sudan must have been exposed to or experienced traumatic events. Throwing the stick forward, a study about the impact of conflicts and war provides a long history of mental health traits (Fitzgerald et al., 2002), and a similar contextual analysis of regional conflict in East Africa provides the same trends (Humphery J. Owjang, 2022).

Suicide is a deliberate action of an individual self – harm to death or a conscious act of taking one's life which results in death. The act of committing suicide starts gradually when an individual is in a distressful situation, he/she will undergo suicidal thoughts as a way of escaping distress. The individual can commit suicide by self-hanging, self-poisoning, self-injuries with sharp objects (gun, knife, etc.), self-throwing from a high level, such as a building or into water (drowning), or fire, etc. Suicide is caused by distressful situations such as severe depression, stress, substance and drug abuse, grief, etc. The risk factors which trigger suicide are death of loved ones, job loss, divorce/separation, financial loss, chronic pain, serious illness, bullying, harassment, alcohol and drugs. At the time of committing suicide, the individual is suffering from a severe mental disorder and self-isolation, where he/she sees no sense in living. Suicidal attempts are acts in which a person tries to commit suicide, but, in the process, someone intervenes and rescues that person from dying. Many suicidal attempts are rescued.

2.0 LITERATURE REVIEW

South Sudan's health system is young, weak and fragile due to the prolonged conflicts, lack of health infrastructure and health personnel's complicated access to health services. The national health budget is (< 10%) annual (National Budget, 2022), leaving health services largely provided by donors. Mental health is not fully integrated into the country's primary health care services. According to Health Action, (40%) of the population show symptoms of PTSD due to war and trauma and about 5.1 million people are affected by mental health conditions (Borgen Project) Mental health services are extremely limited and underdeveloped, less than (1%) of people with mental disorders receive treatment (WHO, 2017), the problem limiting the provision of services is non – existence of the mental health services in the area. There is only one mental health services centre at Juba Teaching Hospital in the whole of South Sudan, with only one psychiatrist. Prolonged conflicts/violence, displacement/refugees, poverty and unemployment are underlying factors contributing to rises in mental health disorders. Due to negligence, mental health is under-supported, and there is less data available.

3.0 METHODOLOGY

Data Source: South Sudan National Demographic Health Information System (DHIS). The National Ministry of Health, in collaboration with the States Ministries of Health and other actors, regularly collected health data across various health facilities in South Sudan. The DHIS data consists of incidences of diseases: number of patients admitted, number of outpatients, age categories, gender of the patient, and state/administrative area by location. The data consisted of all the non-communicable diseases (NCDs) reported, from which mental disorders were extracted for analysis. There are nine mental health-related disorders in the dataset, namely, acute stress, substance and drug abuse, moderate to severe depression, other mental health conditions, other significant mental health complaints, post-traumatic stress disorder, psychosis, suicidal attempts, and grief.

The study is a retrospective observational study involving data that is purely from administrative records from various health facilities at the state/administrative area level. This is aggregated at the national level to reflect national data from 2020 to 2022. The data is submitted by the health facilities via the demographic health information system, a tool for gathering data implemented in many countries in the region and beyond. This data is more reliable and timelier, well recorded via the administrative systems, which are in accordance with the health procedures. However, the data has limitations on coverage and reporting. Access to health services in rural areas is limited; therefore, many people may be sick but never taken to health facilities, and such information is never reported. Many people are dying outside health facilities and are buried without being reported to health facilities. These challenges may affect the accuracy of the data.

The researcher requested data from the Ministry of Health for academic research purposes. The data was examined, and exploratory data analysis (EDA) – descriptive statistics (frequencies and charts) were performed using R statistical software. A data visualisation hub for comparison and exploration has also been developed for this dataset. The use of technology enhanced a better understanding of mental health (Chen et al., 2014). This interactive web-based data visualisation application helps in performing comparisons for annual cases of mental health by age, gender, admission status and types of mental health. The assessment of mental health coverage is always adequate (Campion et al., 2017), but with community participation, a rightful programming can be reached in dealing with primary health issues such as mental health (Cervinskas et al., 1984). The application made it easy to compare these variables. This is the second-highest profiling of mental health in South Sudan, following the World Health Organisation (2017). The Ministry of Health provided ethical approval, individual consent was taken, and the data were anonymised to ensure data privacy.

Table 1: Mental Health Reported Cases by Gender/Inpatient-Outpatient per Year

State/AA	2020				2021				2022			
	Admission		Outpatient		Admission		Outpatient		Admission		Outpatient	
	F	M	F	M	F	M	F	M	F	M	F	M
Abyei	0	0	0	0	0	0	0	0	0	0	0	0
CES	5	32	656	701	26	11	1437	1389	48	14	1151	1285
EES	22	19	2294	1922	18	16	3142	2405	56	43	5566	5124
Jonglei	6	0	179	105	8	1	321	196	3	6	551	433
Lakes	146	48	516	426	35	10	625	570	50	8	383	305
NBGS	125	49	916	672	172	137	2209	1935	202	175	1782	1916
Pibor	0	0	2	8	0	0	11	20	0	0	27	54
Ruweng	38	35	220	242	19	7	114	89	429	282	138	148
Unity	1	8	374	436	24	13	765	750	24	11	1272	1639
UNS	0	0	243	330	0	0	88	114	0	0	687	670
Warrap	14	4	1301	1217	11	0	1355	1273	67	5	1071	1019
WBGS	0	0	1247	1136	1	0	505	449	0	0	1080	623
WES	19	17	1010	1084	19	10	1521	1619	46	27	1363	1366
Total	376	212	8958	8279	333	205	12093	10809	925	571	15071	14582

4.0 FINDINGS AND DISCUSSION

South Sudan's Mental Health Data Visualisations and Analysis

Alcohol and substance abuse and suicide are the leading mental health problems with the highest death figures.

Table 2: Mental Health Reported Cases by Types of Mental Disorder and Age per Year

Types of mental health	Patients Cases		Deaths Cases	
	Number	Percentage	Number	Percentage
Alcohol and Substances Abuse	33,927	47%	71	33%
Suicide	1,725	2%	65	30%
Psychosis	0	0%	28	13%
Other significant mental health Complaints	4,729	7%	21	10%
Acute Stress	12,201	17%	20	9%
Depression	3,342	5%	8	4%
Post – traumatic stress disorder (PTSD)	4,485	6%	2	1%
Other mental health conditions	9,619	13%	1	0%
Grief	2,386	3%	1	0%
Total	**72,414**	**100%**	**217**	**100%**

4.1. Acute Stress

4.1.1. Overview of Reported Cases for Acute Stress

In South Sudan, the level of stress encountered by individuals is very high; the historical paths (Dan et al., 2017) the country has gone through have impaired many systems that support individual well-being. The inability of an individual to get employment causes stress, the inability of an individual to pay for his children's school fees, hospital bills, buy food, clothes or any personal or family needs causes stress. Among the mental disorder cases at the various diagnostic health facilities in South Sudan, acute stress accounts for (12%) in 2020, (17%) in 2021 and (20%) in 2022. Over the past three years, we have had a total of 12,201 acute stress cases in South Sudan, of which (17.5%), (32.2%) and (50.3%) were recorded in 2020, 2021 and 2022, respectively. A total of (12.6%) of the reported acute stress cases were inpatients. In 2020, 2021 and 2022, the under-5-year-old reported cases were (23.5%), (24.2%) and (17.0%), respectively. The remaining percentage of the cases presents the cases over 5 years. This shows that acute stress has been increasing over the past three years at a rate of (41%). By gender, the proportion of females reported with acute stress in the years 2020, 2021 and 2022 was (60.4%), (57.0%) and (58.6%), respectively. This indicates a high prevalence of acute stress among women compared to men.

Ruweng Administrative has more acute stress inpatient cases in 2022, followed by Northern Bahr El-Ghazal State. There were increases in the number of reported inpatient cases between 2020 and 2022. The chart below presents the overview of the acute stress reported inpatient cases across the states/administrative areas in South Sudan from 2020 to 2022. A combination of demographic and clinical variables, with strong contributions from symptoms of depressed mood, reduced interest, decreased activity, indecisiveness, pessimism and anxiety, significantly predicted treatment outcomes, explaining (5-10%) of variance in symptom improvement with escitalopram (Iniesta et al., 2016).

In examining the reported acute stress outpatient cases, Eastern Equatoria State, followed by Central Equatoria State, had the highest reported cases in 2022. There were more acute stress cases reported by outpatients, a few inpatient cases and fewer inpatient death cases each year. All the reported death cases were inpatient cases. From the total annual deaths in 2020, 2021 and 2022, the proportion of the acute stress deaths was (5.9%), (4.7%) and (14.6%), respectively. This indicates an increasing trend in the total number of deaths. Out of 227 inpatients/admitted acute stress cases in 2020, about (2.2%) die. Similarly, in 2021, out of 232 inpatients/admitted acute stress cases (0.86%) died, and in 2022, out of 1,078 inpatient cases (1.2%) died. The low health budgetary allocation (< 10% annual) complicated the interventions (World Bank report, 2022).

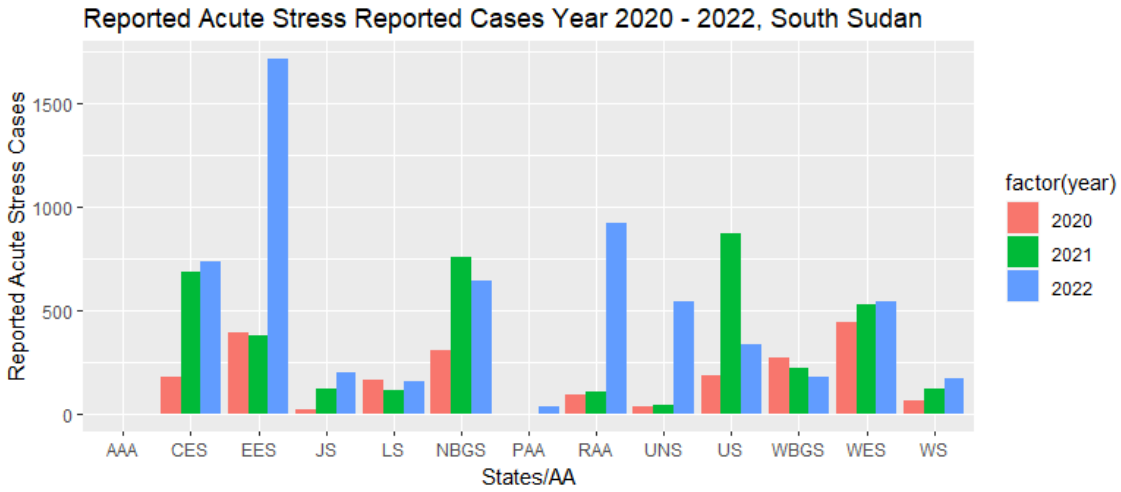

Figure 1: Reported Acute Stress Cases, 2020–2022

The trend visualisation of the reported acute stress cases per states/administrative areas in South Sudan. The states/administrative areas with progressive increases of acute stress annually are Central Equatoria State, Western Equatoria State, Eastern Equatoria State, Jonglei State, Warrap State, Ruweng Administrative Area and Pibor Administrative Area. The decline in the number of acute stress cases was only seen in Western Bahr el Ghazal State. There is no data recorded for the Abyei Administrative Area over the past 3 years.

Stress affects our performance at the workplace, school, in society, or anywhere we are expected to deliver a positive impact or causes acute deaths. Therefore, paying attention to issues that cause stress is vital for the mind and body to function in a stress-free environment. This stress-free environment cannot be easily achieved, but we must minimise stressful players. The use of technology provided a better understanding of mental health patterns and issues in society (Bone et al., 2017).

4.1.2. Overview of Reported Death Cases for Acute Stress

Few acute stress death cases (n = 20) were reported in South Sudan between 2020 and 2022. This number is distributed for the years 2020, 2021 and 2022 as follows: (25%), (10%) and (65%) respectively. The poor data quality should be attributed to the lack of data reported. In 2020, only Central Equatoria State (n=2), Northern Bahr el Ghazal State (n=2) and Western Equatoria State (n =1) had reported acute stress deaths. While in 2021, only Eastern Equatoria State (n=1) and Lakes State (n=1) had reported acute stress deaths, and in 2022, Lakes State (n=1), Northern Bahr el Ghazal State (n=9), and Ruweng Administrative Area (n=3) had reported death cases. The overall reported deaths during the past 3 years put Northern Bahr El-Ghazal State and Ruweng Administrative Area at the leading. Most of these acute stress deaths occur among females.

4.2. Alcohol and Drug Abuse

4.2.1. Overview of Reported Cases for Alcohol and Drug Abuse

In South Sudan, alcohol and drug abuse are the leading mental health concerns; several factors are promoting alcohol and drug abuse. These factors include poverty, peer group pressure, false fantasy of success, high level of ignorance, test and curiosity, high level of stress and addictions. Most of the drugs are illegal in South Sudan except alcohol and tobacco, but smugglers and other distributors have made

them accessible. Young people are the main users of these drugs. South Sudan is a country that emerged from decades of civil wars and conflicts, which had subjected its people to numerous social injustices, political injustices and economic injustices. These injustices had permanent damage to individual life, communal settings and nation-building. The inability of an individual to meet his/her personal needs causes stress, and that leads to substance and drug abuse. The assessment of public mental health, collaborative advocacy and leadership with practical information, policy and implementation is desired (Campion et al, 2022).

Substance and drug abuse is the leading mental disorder in South Sudan in terms of the number of reported cases. The proportion of substance and drugs abuse cases among the overall mental health cases in 2020 (n = 9,328), 2021 (n = 11,725) and 2022 (n = 12,874) were (52%) (49.4% female and 55.6% male), (50%) (49.7% female and 50.3% male) and (41%) (47.6% female and 52.4% male) respectively. All the reported substance and drug cases were outpatients and death cases. This indicates men are slightly higher compared with women in substance and drug abuse. Over the past 3 years, about (0.6%) of substance and drug abuse cases were under 5 years (n = 176 cases). The proportion of under-5-year cases compared with over-5-year cases each year from 2020, 2021, and 2022 is (0.26%) (with 75% of the cases being female), (0.53%) (with 63% being female cases) and (1.17%)(with 60% being female cases), respectively. Among the over 5 years, the proportion of females in 2020, 2021 and 2022 was (49.3%), (49.6%), (47.5%), respectively. There are progressive increments in the number of alcohol and drug abuse cases in South Sudan. Eastern Equatoria State has the highest number of alcohol and drug abuse cases, followed by Warrap State.

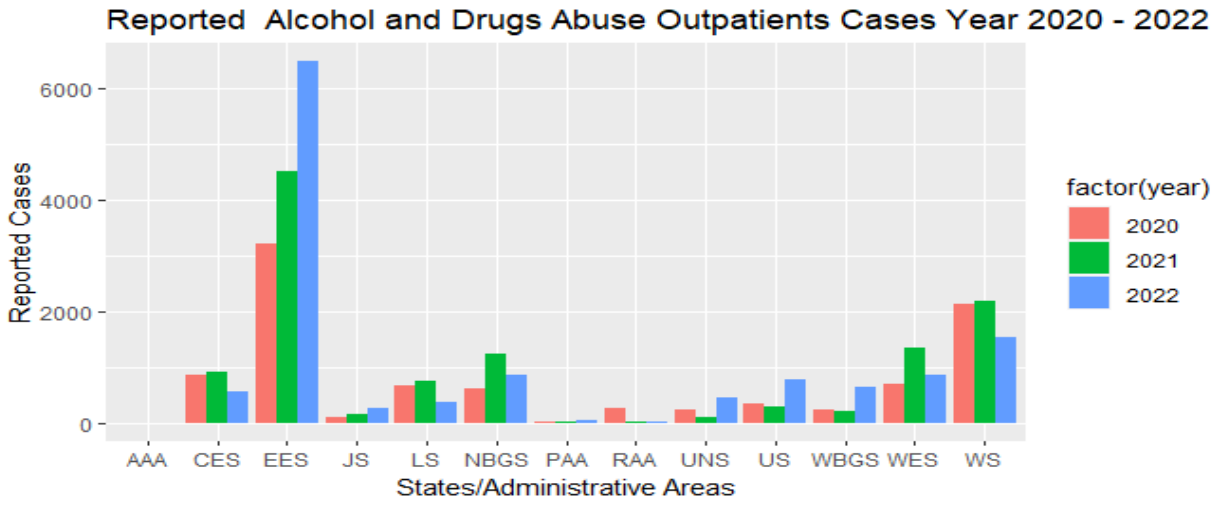

Figure 2: Annual Reported Outpatient Cases of Alcohol and Drug Abuse per State/Administrative Area

An increase in the pattern of substance and drug abuse has been observed in Eastern Equatoria State, Unity State, Western Bahr El-Ghazal State, Jonglei State and Pibor Administrative Area between 2020 and 2022.

4.2.2. Overview of Reported Death Cases for Alcohol and Drug Abuse

Among all the mental health deaths in South Sudan, alcohol and drug abuse deaths are leading. (35.3%) Of all mental health deaths in 2020 were due to alcohol and drug abuse , (32.6%) of all the mental health

deaths in 2021 were due to alcohol and drug abuse and (30.3%) of all mental health deaths in 2022 were due to alcohol and drug abuse. The chart below presents the distribution of deaths due to alcohol and drugs per state/administrative area of South Sudan. Eastern Equatoria has the highest number of substance and drug cases (both patients and deaths).

4.3. Grief

4.3.1. Overview of Reported Cases of Grief

In South Sudan, several factors lead to grief cases. Abrupt loss of loved ones, properties/assets, or cash is common in South Sudan due to the political and economic instability. These factors increase the chances of the occurrence of grief. All the grief reported cases were outpatient cases. Statistics show that (3.29%) (n =2,386) of the mental health cases in South Sudan over the past 3 years were due to grief. These cases are distributed as follows; (12.2%) (with 6.85% being under 5 years cases) of the grief cases where in 2020, (34.1%) (with 4.55% being under 5 years cases) of the grief cases in 2021 and (53.7%) (with 6.56% being under 5 years cases) of the grief cases in 2022. About (0.04%) of the reported grief cases over the past three years have died. There is a record of (4.15%) of the grief cases being under 5 years of grief cases and (62.15%) of the grief cases being female cases over the past 3 years. This shows that most of the grief cases are female cases. The proportion of female grief among the under 5 years old in 2020, 2021 and 2022 is (45.0%), (51.4%) and (50.0%) respectively, whereas the proportion of females among the over 5 years old in 2020, 2021 and 2022 is (62.5%), (62.6%) and (63.2%) respectively.

There is an increasing trend in the number of grief cases annually. For each year, we have the following grief cases: 2020 (n =281), 2021 (n =284) and 2022 (n =1,281). The increases indicate that there is an increasing accelerator or cause of grief, which could mean an increase in acute loss of loved ones or a source of livelihood. The economic hardship has also weakened the ability of citizens to afford food and health services, which can result in abrupt losses that are very painful.

In 2020, Eastern Equatoria State was leading in the number of grief cases, but in 2021 and 2022, Northern Bahr El-Ghazal State has been leading in the number of grief cases. An increasing trend in the number of griefs is observed in Northern Bahr El-Ghazal State, Western Equatoria State, Eastern Equatoria State, Warrap State, Jonglei State, Western Bahr El-Ghazal State and Pibor Administrative Area. Erratic pattern in the grief was observed in Central Equatoria State, Unity State, Lakes State, Upper Nile State and Ruweng Administrative Area.

4.3.2. Overview of Reported Death Cases for Grief

Grief death can occur when the person has sudden shock, or refuses to eat, then dies of starvation, or refuses to drink and dies of dehydration or hurt her/himself (suicide), or the grief develops into depression or acute stress. A person with high grief may have lost his mind, the psychological being and become distressful to the family. Substance and drug abuse are common after the person has partially recovered from grief stress or continuous depression. Only one male death incidence due to grief was reported in Jonglei State in 2022.

4.4. Moderate - Severe Depressive Disorder

4.4.1. Overview of Reported Cases for Moderate – Severe Depressive Disorder

In South Sudan, (4.62%) (n = 3,342) of the total reported mental health cases (n = 72,414) were due to moderate – severe depression. About (7.06%) of the total 3–year moderate–severe depression cases were

under 5 years old, and (53.7%) of the overall 3-year depression cases were female. Women are more depressed in South Sudan than men; this could be because of the role women play in the household. Most women are not financially independent and have to struggle to take care of their families. Men are less directly involved in most of the household activities, giving them freedom to share their social life with friends.

The annual reported moderate – severe depressive disorder cases in South Sudan are: in 2020 (n = 727 cases, 21.8%), 2021 (n=1,172 cases, 35.1%) and 2022 (n = 1,443cases, 43.2%). The proportion of females with moderate – severe depressive disorder in 2020, 2021 and 2022 is (50.6%), (56.1%) and (53.2%), respectively. Among the under-5-year-old children, the proportion of females with moderate – severe depressive disorders in 2020, 2021 and 2022 is (54.4%), (53.6%) and (56.6%) respectively. While the proportion of females among the over years in 2020, 2021 and 2022 are (49.7%), (56.3%) and (53.0%) respectively. These statistics show that the cases of moderate – severe depression are on a rising trend. All the depression cases were outpatients cases. About (1.18%) of the mental health deaths in 2020 were due to depression; no depression deaths were recorded in 2021, but (7.87%) of the mental disorders deaths in 2022 were due to depression. All the reported depression deaths were men. From these depression deaths (n = 8) between 2020 and 2022, (12.5%) were children under 5 years old.

In 2020, a higher number of cases of moderate – severe depressive disorders were reported in Upper Nile State and Warrap State, but in 2021, Northern Bahr El-Ghazal State and Central Equatoria State were leading in the number of depression cases and in 2022, Northern Bahr El-Ghazal State, Eastern Equatoria State and Central Equatoria had the highest cases.

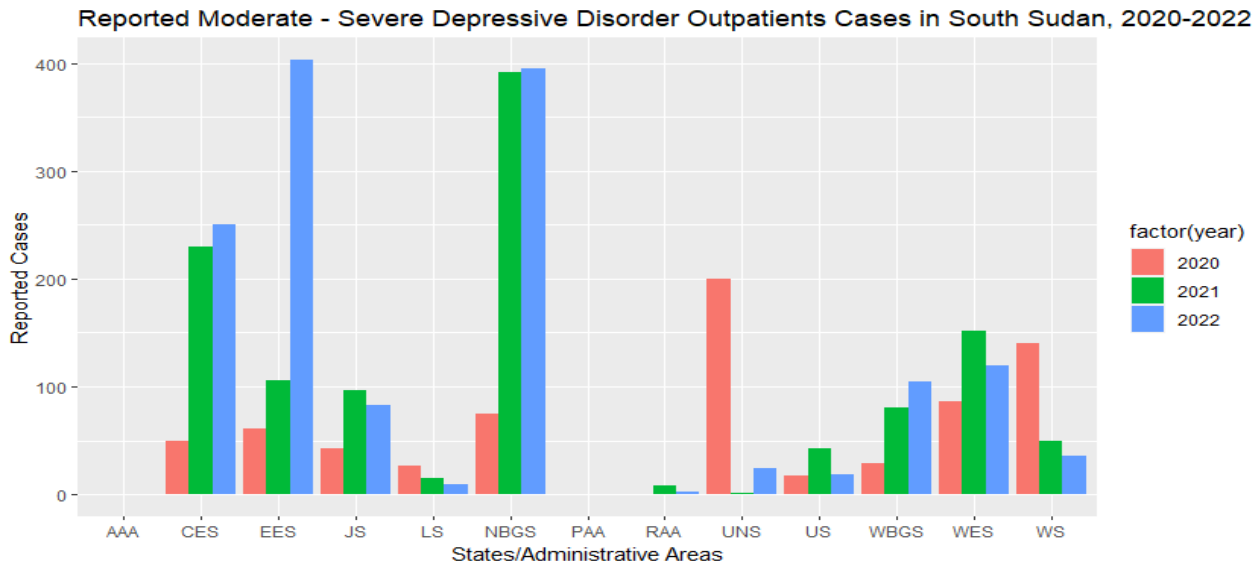

Figure 3: Reported Moderate–Severe Depressive Disorder Cases per State/Administrative Area

It is observed in Central Equatoria State, Eastern Equatoria State and Western Bahr El-Ghazal State that the cases of moderate – severe depressive disorders were increasing. While a decrease was observed in Warrap State and Lakes State. The other states had irregular patterns in the annual number of cases whose tendency cannot easily be observed.

4.4.2. Overview of Reported Death Cases for Moderate – Severe Depressive Disorder

There was a total of 8 deaths due to moderate – severe depressive disorders in South Sudan between 2020 and 2022. One case in Eastern Equatoria State in 2020 and three to four cases in Jonglei State and Northern Bahr El-Ghazal State, respectively, in 2022.

4.5. Other Mental Health Conditions

4.5.1. Overview of Reported Cases for Other Mental Health Conditions

The national health data in South Sudan indicate that other mental health conditions constitute (13.3%) (n= 9,619) of the total mental health reported cases (n = 72,414) from 2020 to 2022. Each year, the cases are: 2020 (n = 2,311 or 24.0%), 2021 (n = 2,241 or 23.3%) and 2022 (n = 5,067 or 52.7%). The proportion of other mental health conditions inpatients (admitted cases) from the total 3-year cases is (6.54%) while the remaining percentage were outpatient cases. The proportion of other mental health conditions by each category (inpatients, outpatients) is 2020 (10.0%, 90.0%), 2021 (6.6%, 93.4%) and 2022 (4.9%, 95.1%). The proportions by gender (female, male) are 2020 (52.5%, 47.5%), 2021 (51.9%, 48.1 %) and 2022 (49.7%, 50.3%). About (14.6%) (1,401) of the other mental health conditions in the past three years were in children under 5 years old. In 2020, 2021 and 2022, the percentage of children under 5 years old is (21.2%) (n=489 cases with (61.8%) been female), (7.9%) (n = 178 cases with (68.5%) being female) and (14.5%) (n = 734 cases with (50.7%) being female), respectively, and the remaining percentage represents over 5 years old. This is a huge proportion of children less than 5 years old experiencing mental health conditions. This is also a clear indication that their parents are going through severe mental disorders prior to giving birth. The over 5-year case distributions by gender (female, male) in 2020, 2021 and 2022 are (50%, 50%), (50.5%, 49.5%) and 49.5%, 50.5%), respectively. There was only one male over 5 years old who died in 2021.

In 2020, Ruweng Administrative Area had the highest number of inpatient cases, followed by Northern Bahr El-Ghazal State and Lakes State. In 2021, Northern Bahr El-Ghazal State had the highest number of inpatients among Lakes State and Pibor Administrative Area. In 2022, Northern Bahr El-Ghazal State had the highest number of inpatient cases, followed by Western Equatoria State and Unity State. The state/administrative area with the highest outpatient cases is Western Bahr El-Ghazal State, Western Equatoria State and Unity State in 2020, 2021 and 2022, respectively.

4.5.2. Overview of Reported Death Cases for Other Mental Health Conditions

There was only one male over 5 years old who died in Lakes State in 2021

4.6. Other Significant Mental Health Complaints

4.6.1. Overview of Reported Cases for Other Significant Mental Health Complaints

Six-point 5 per cent (or n = 4,729 with (48.6%) of these cases as females, (20.2%) under 5 years children and (9.6%) inpatients cases) of the reported mental health cases from 2020 to 2022 in South Sudan were classified as other significant mental health complaints. The annual proportion of other significant mental health complaints from the mental health data is as follows: in 2020, the cases were (8.5%) (or n = 1,514 with (52.6%) of these cases as female cases, (8.5%) inpatients and (24.8%) under 5 years old children. In 2021, they cases were (5.0%) (or n = 1,164 with (54.0%) of these cases as female cases, (13.6%) inpatients and (93.7%) under 5 years children) and in 2022, they cases were (6.6%) (or n = 2,051 with (42.6%) of these cases as female cases, (8.2%) inpatients and (3.0%) under 5 years children) respectively. In the year 2021, nearly all cases were of children under 5 years old.

Northern Bahr El-Ghazal State has the highest number of other significant mental health complaints inpatient cases for over three consecutive years. This indicates the presence of higher causative factors for mental health disorders in this state. The extreme numbers of significant mental health complaints were reported in Western Bahr el Ghazal State, Northern Bahr el Ghazal State, Central Equatoria State and Unity State over the past three years. The visualisation of the other significant mental health complaints (inpatient cases + outpatient cases) in South Sudan annually between 2020 – 2022, puts Western Bahr el Ghazal State with the highest number of reported cases in 2020. Northern Bahr el Ghazal State has progressively seen increases annually in the number of cases. Progressive increments in the number of cases are seen in Northern Bahr el Ghazal State, Central Equatoria State, Eastern Equatoria and Unity State. While a decrease in the number of cases is seen in Western Equatoria State only, the rest do not have a unique trend in their annual reported cases.

4.6.2. Overview of Reported Death Cases for Other Significant Mental Health Complaints

Of the 3-year mental health reported deaths in South Sudan, (9.7%) (n = 21) of the deaths were due to other significant mental health complaints. In 2020, 2021 and 2022, the proportion of other significant mental health complaints deaths was (3.5%, 23.3%) and (9.0%) respectively. All the other significant mental health deaths occur in patients over 5 years old. There were three deaths (2 female and 1 male) in 2020, 10 deaths (3 females and 7 males) in 2021 and 8 deaths (2 female and 6 males) in 2022. All the 21 reported other significant mental health complaints deaths occurred in Northern Bahr el Ghazal State (n = 20, 3 deaths in 2020, 9 deaths in 2021 and 8 deaths in 2022) and Central Equatoria State (n = 1 death in 2021).

4.7. Post-Traumatic Stress Disorder Cases

4.7.1. Overview of Reported Cases of Post-Traumatic Stress Disorder

The DHIS statistics indicate (6.2%) (n = 4,485)of the reported mental health cases to be PTSD, with (5.2%) cases being under 5 years of age, and the remaining percentage being over 5 years of age. All the PTSD reported cases were outpatient cases. The 2020 PTSD cases are 1,016 (22.7%), the 2021 PTSD cases are 1,843 (41.1%), and the 2022 PTSD cases are 1,626 (36.3%). The proportion of females with PTSD in 2020, 2021 and 2022 is (56.9%, 55.3% and 53.6%), respectively, and the remaining proportion represents males reported with PTSD. Forty-six out of 976 PTSD cases in 2020 were children under 5 years old, similarly 121/1,883 were under 5 years old in 2021, and 66/1,626 were under 5 years old in 2022. Among under 5 years PTSD cases, the proportion of females in 2020, 2021 and 2022 was (53.5%, 556.8% and 548.5%) respectively. While among the over 5-year PTSD cases, the proportion of females in 2020, 2021 and 2022 was (57.2%, 55.2% and 53.8%), respectively. Conclusions: In this first proof-of-concept application of data and machine learning methods to predict childhood Posttraumatic Stress, we were able to determine both predictive classification models for childhood PTSD and identify several causal variables (Sax et al., 2017).

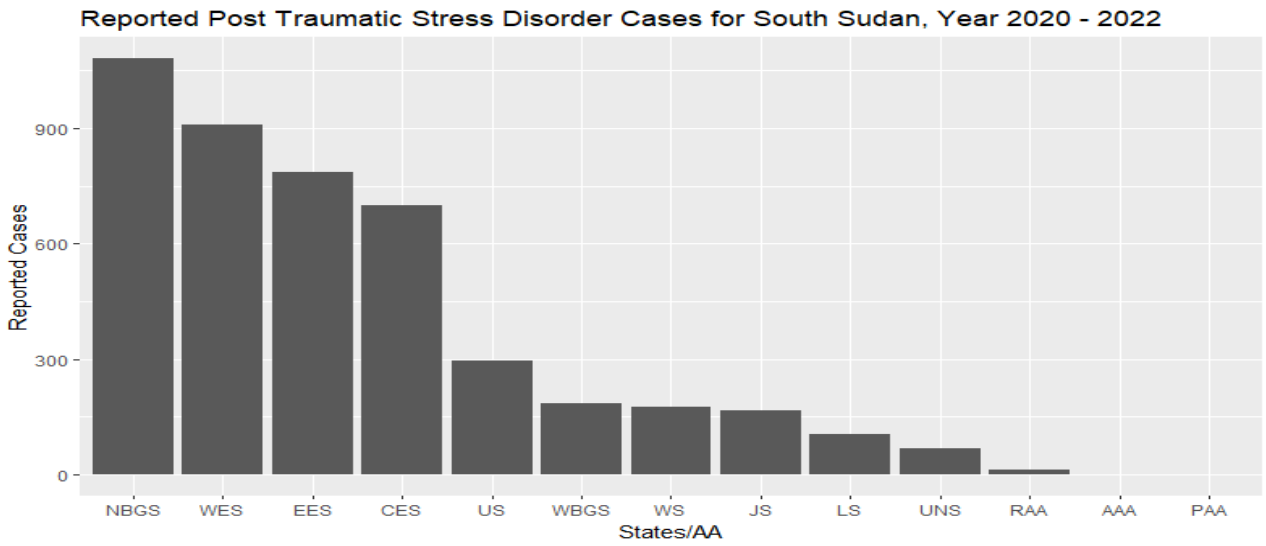

Figure 4: Three-Year Cumulative PTSD Cases in South Sudan, 2020–2022

4.7.2. Overview of Reported Death Cases for Post-Traumatic Stress Disorder

There were only two deaths (1 male and 1 female) in Central Equatoria State in 2020.

4.8. Psychosis

4.8.1. Overview of Reported Cases for Psychosis

African societies do not support people suffering from psychosis; they are usually considered mad people whose spirits might have been taken away from them. In most communities, they are left roaming around the streets without anyone accepting them. The few whose relatives may feel ashamed when they see them misbehaving on the streets are chained up at home. People suffering from psychosis are getting little access to medical services and care.

The situation in South Sudan is like the situation in many African countries, or far worse than that. South Sudan has no single mental health hospital or mental health rehabilitation/psychosocial support centre. The urban cities lack a clinic; only psychiatric professionals work in Juba, therefore, it is rarely worse at the rural level. Most of the people suffering from psychosis are chained at home, on the streets or taken to prisons for detention. This practice limited interventions. Due to this societal approach to a person suffering from psychosis, there were no reported cases of psychosis in South Sudan over the past three years. Through observation, there are many people suffering from psychosis in the streets or in the neighbourhoods where cases of psychosis are higher, but there are no proper means to get the data. The DHIS approach may not be the best option for gathering psychosis data in South Sudan. Therefore, it will be good to conduct Early Recognition of Psychosis Using MRI-Based Methods (Koutsouleris et al., 2012). The study found the existence of many psychosis cases within the community which are not reported to health centres.

4.8.2. Overview of Reported Death Cases for Psychosis

The death statistics: (12.9%) (n = 28, with 60.7% females death cases and 14.3% of children under 5 years old) of the mental health deaths in South Sudan were due to psychosis. Fourteen per cent of the deaths occurred in 2020, (32%) in 2021 and (54%) in 2022. The care and management of patients with psychosis requires a professional health facility. This can be unaffordable for most people. From the death

information, we observed a very steep slope in the number of psychosis deaths annually in South Sudan. Between 2020 and 2021, the number of psychosis deaths increased by (125%) and between 2021 and 2022, the number of psychosis deaths increased by (67%). These deaths occur within the community, outside the health facilities, and therefore, a good strategy in collecting the correct psychosis data is vital. The chart below presents the psychosis cases between 2020 and 2022; there were no cases of psychosis (inpatients and outpatients), but only death cases.

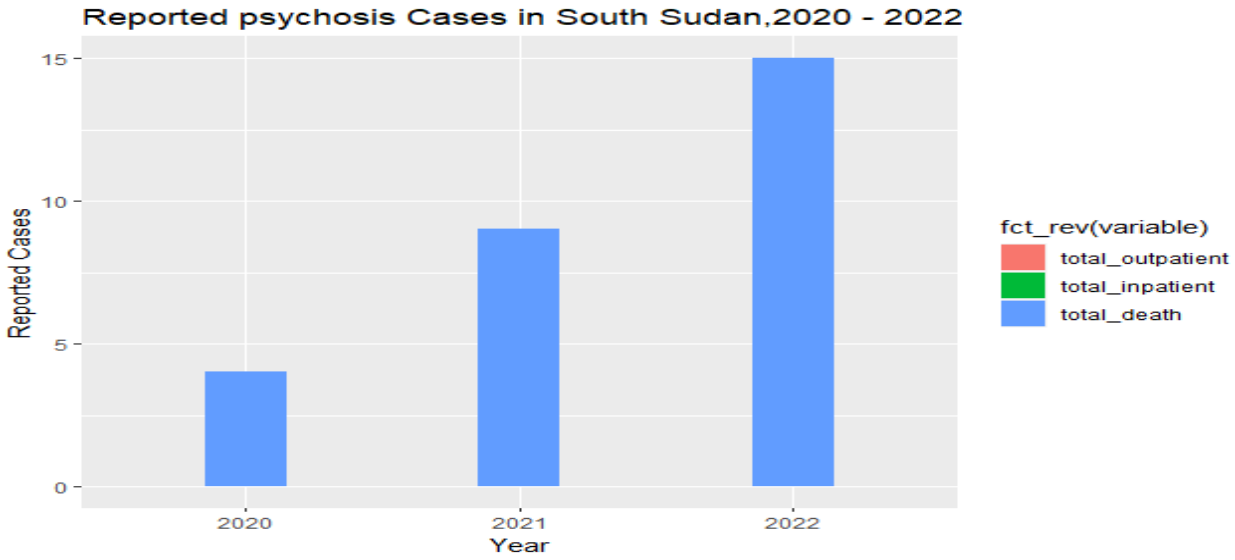

Figure 5: Reported Psychosis Cases in South Sudan, 2020–2022

The reported psychosis deaths occur in Lakes State (n = 3) and Northern Bahr el Ghazal state (n = 1) in 2020, in Central Equatoria State (n = 1), Eastern Equatoria State (n = 7) and Lakes State (n = 1) in 2021 and in Central Equatoria State (n = 2) and Northern Bahr el Ghazal State (n = 14) in 2022. The cumulative psychosis cases put Northern Bahr el Ghazal State (n = 15 death cases) with the highest number of deaths, followed by Eastern Equatoria State (n = 7 death cases), Lakes State (n = 4 death cases) and Central Equatoria State (n = 3 death cases).

4.9. Suicide Attempts and Suicide

4.9.1. Overview of Reported Cases for Suicide Attempts

A total of 1,725 suicidal attempts were reported in South Sudan from 2020 to 2022. In every 100 persons who attempted suicide over the past 3 years, 66 are females, and 34 are males. In every 100 suicide attempt cases, 2 are under 5-year-old children. It is very rare to find children under 5 years attempting to commit suicide, but the data has presented cases where children under 5 years attempt suicide. The distributions of these reported cases annually are 507 (29.4%), 551 (32.9%) and 667 (38.7%). All the reported attempted suicide cases are outpatient cases. Each year, the proportion of females who attempt suicide is (60.4%, 70.4% and 65.8%). The chart below presents annual suicidal attempt cases by admission status (inpatients /outpatients and death). It is easy to notice that there were no reported inpatient cases; only outpatient cases and deaths were reported. The higher number of suicidal attempts is observed in Northern Bahr el Ghazal State and Eastern Equatoria State.

The chart above presents the visualisation of the suicidal attempts' cases in South Sudan from 2020to 2022. This information can inform all policymakers about the states/administrative units where interventions are needed. The adoption of data-intensive machine-learning methods can be found throughout science, technology and commerce, leading to more evidence-based decision-making across many walks of life, including health care, manufacturing, education, financial modelling, policing, and marketing (Jordan et al., 2015). This application is extended to big data analysis (Luo et al., 2016). PRISM (Passive, Real-Time Information for Sensing Mental Health) is one of the successful data platforms for monitoring mental health (Kamdar et al., 2016). Suicidal is one of the extreme decisions a person with severe distressful problems can make.

4.9.2. Overview of Reported Death Cases for Suicide

Suicide deaths are second after substance and drug abuse, taking away the lives of people in South Sudan. Suicide deaths account for (20.2%) (n =65 with about 50.8% female deaths, and (41.5%) under 5 years deaths, from overall mental deaths in South Sudan in the past three years. The higher number of suicide deaths (41.5%) is something that is alarming if true and needs further investigation. Sixty-one per cent of the deaths occurred in 2020, ten per cent in 2021 and twenty-seven per cent in 2022. Jonglei State has the highest cumulative suicide deaths in South Sudan, followed by Northern Bahr el Ghazal State and Eastern Equatoria State. Generally, depression is the major contributor to suicide deaths, with nearly 800,000 deaths per year globally attributed to this condition (WHO, 2015).

5.0 CONCLUSION AND RECOMMENDATIONS

Conclusion: Research on non-communicable diseases, especially public mental health, is crucial. This exploratory data analysis provides overwhelming, vital statistical information that will make people understand the magnitude of mental health in the community. In South Sudan, health services are underfunded by the government, leaving international development partners to step in to provide basic health services. The annual budget is always less than (7%), and the country has inadequate health resources (health facilities and professionals). This problem is far worse when it comes to mental health.

The mental health data presented in the demographic health information system (DHIS) had some data gaps, some important variables are capture in the data collection tool, these variables include medicated history of the patients (such as duration of sickness, medicines provided, other medical history etc), economic activities, employment status of the patients, income, marital status, household size, number of specialist mental health professionals in each health facility around the country etc.

In the population of 100,000 people, 19,397 people experienced a mental health disorder every year. The prevalence of mental health issues is higher among females compared to males. This implies that women are highly exposed to mental health causative factors. There is a significant number of mental health cases among children under 5 years old, meaning there is an inheritance of mental disorders by children, which requires preventive measures to avoid the transfer of this mental disorder to children. There are critical incidents where the patients are admitted for special care and management. The annual increment in the number of mental health disorders is (32%). Due to this increase in the number of mental disorders, there is an increase in the number of substance and drug abuse, acute stress and other mental health conditions. There is equal prevalence of mental disorders across the states and administrative areas in South Sudan. They state that the higher number of mental disorders is in Eastern Equatoria, Warrap, Western Bahr el Ghazal, Western Equatoria and Northern Bahr el Ghazal. Mental deaths reported occurred among the

inpatients; the study found that out of 100 inpatients, 10 are likely to die. Therefore, mental health is a significant burden in South Sudan.

The predicted linear model at a (95%) confidence level extrapolates the mental health cases; the model found that the annual reported cases will be increasing at the rate of 13.5% if no major health interventions are implemented in South Sudan between 2023 and 2030. Substance abuse and acute stress are the leading mental problems in South Sudan. Several factors associated with the increase in mental health cases are poverty, poor income, wars & conflicts, domestic violence, poor upbringing of children and poor health services.

Recommendations: The Ministry of Health should review the DHIS tool to include variables such as medical history of the patients, employment status, income, and substance use. Additionally, the Ministry of Health should lobby for budgetary allocations to finance mental health interventions in all states and administrative areas. It is also necessary for the Ministry of Health to increase the number of mental health facilities and mental health professionals in the country. The Ministry of Health, together with the Ministry of Interior, the Ministry of Gender, Child and Social Welfare, and other development partners, should advocate for the rights of people with mental disorders, especially those suffering from psychosis.

The National Bureau of Statistics should include a module on mental health in the upcoming national household baseline survey, particularly to determine the number of psychosis cases in the community. Furthermore, the mental health risk environment and risk factors that are promoting increases in the number of mental health cases should be minimised. These factors include economic factors such as financial stress, lack of employment, job loss, and inflation; health factors such as chronic diseases, limited access to health services, and high treatment costs; and social factors such as conflicts, violence, cultural influences, religion, and marriages.

There is also a need to develop a national mental health strategy aimed at reducing the annual increment of cases from the current rate of 32 per cent to 10 per cent by 2030. In addition, the development of a birth and death registration policy is required. Relevant institutions regulating substances and drugs should enforce maximum restrictions on their consumption. Women should be protected from all social, economic, and political injustices. Frequent welfare monitoring surveys should be conducted to assess the well-being and level of happiness in the country.

It is important to increase the use of statistics in formulating policies and interventions that are supported by factual data. To resolve mental health challenges, the government needs to increase spending on wellness and introduce new legislation that provides employers and insurance providers with tools to encourage preventive care, following the direction suggested by Agarwal et al. (2016) and using population approaches (Campion et al., 2018).

Policy Implications

The study provides a comprehensive statistical overview of mental health problems in South Sudan, which aids in facilitating policy formulation and the implementation roadmap. These implications include increasing the number of mental health practitioners, establishing additional mental health facilities, increasing health budget allocations, and investing in mental health statistics. Failure to address mental

health problems has long-term effects on community and individual prosperity, productivity, and may contribute to the recurrence of conflict.

Acknowledgement
I thank the Ministry of Health for providing the data. I acknowledge the conducive environment and support provided by my university, the University of Juba, and my loving family, including my wife Alakiir Ajang, my son Buldit, my daughters Ajahdit and Apajokdit, my sisters, brothers, and extended family members.

Authors Contributions Declaration
ABM led the conceptualisation, methodology, formal analysis, and initial drafting of the manuscript. TKKK contributed to the methodology and provided overall supervision. DMN offered subject-matter expertise in mental health and contributed to the manuscript's critical revision. SWL supervised the work and reviewed the manuscript. ZMSM supervised the statistical methodology, guided the interpretation of results, and provided critical revisions to enhance the academic rigour of the paper. All authors reviewed and approved the final version of the manuscript.

Funding Declaration
The research had no external funding but was self-financed.

Conflict of Interest Statement
The authors have no conflict of interest in this study.

Ethical Statement
The dataset was provided by the South Sudan National Ministry of Health. The data were anonymised and approved for public use. Data handling followed the standards set in the Code of Conduct for Official Statistics (NBS, 2019).

Data Availability Statement
The data used in this study are public and can be shared with anyone interested in using them.

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